ECE 5358/6358 - Report 1 on the experiment in class

Assignment: Write a short report in your own words following the framework given below. In other words, do not write randomly but try to follow the logical structure given.

In the follow, normal font represents the topic that you will address. *Italic font is for instuctor's thoughts and ideas as hint. Do not include the hint text verbatim in your report.*

A. Experimental demonstration

We had an experimental demonstration in the class that leads to this conclusion: light does not change its frequency when going through dielectric spectral filters. Explain how we reach that conclusion. (present the evidence supporting that conclusion, this is an experimental inference, NOT because some theory says so).

Hint: The reason for white light to look colorful after a filter is simply because the different frequency components of white light are absorbed differently (or unevenly). Imagine we have a party with 100 different dishes, the guests who came did not have uniform random taste: stuff like King crabs, caviar, tuna sashimi disappeared quickly, while nobody touched chicken nuggets and macaroni and cheese. After awhile, certain dishes were totally gone, and a late comer would think that the party served just those dishes. On the other hand, another party served only one dish, pizza. After awhile, there was less pizza, but a late comer would still make a correct assessment that the party served pizza.

B. How to account for the phenomenon

Is there a theory in physical science that we think we can apply to explain for what we observe? What is it?

Hint: every natural phenomenon, unless it is a new discovery of hitherto unknown law of nature, can be accounted by the existing scientific theories. We have Newtonian mechanics, Quantum mechanics, classical E&M (Maxwell's theory), Relativistic Quantum theory, General Relativity (inc. gravity), Grand Unification Theory that can explain all physical phenomena. Learn to classify phenomena such that you will know what theory to use.

C. Exactly what part of the theory that can be used to

explain

It is one important step to identify the theory, but it is also essential to identify the specific part or aspect of the theory (represented by a specific equation) that can be used to explain the observation in 1. In the class, we use the demo below to cite the specific aspect of the theory that can be used.

1- what is it? and what is its equation? (either in integral form or differential form, or both).

2- A person argues that it makes no sense because the video is about radio sound, how can this have anything to do with a toally different thing such as light. What would be your reply?

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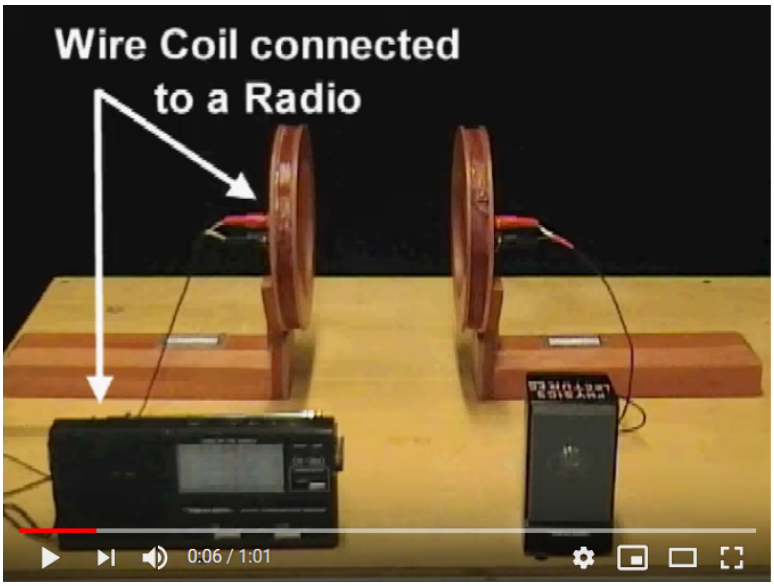

Hint: It's Faraday's law. The coil attached to the radio output generates a magnetic induction field:

$H[\mathbf{x},t]$ *where* $\mathbf{x}$ *is the space.*

The coil on the right connected to the speaker obeys Faraday's law:

$$\int_{\text{complete loop}}^{\square} \mathbf{E}.d\mathbf{l} = -\frac{\partial}{\partial t}\int_{\text{coil area}}^{\square} \boldsymbol{H}.d\boldsymbol{S} \sim n\,\pi\,r_2^2\,H_0[\boldsymbol{x},t] \quad \text{(n: number of loops)}$$

$$E \sim \frac{\pi r_2^2}{2\pi r_1} H_0[\boldsymbol{x},t]$$

Hence, the speaker current picks up the same audio signal generated by the radio coil. A more common application is the transformer in every AC/DC adapter (your computer, cell phone chargers).

D. Apply the theory to prove the observation in 1 above

Hint: apply $\int_{\text{complete loop}}^{\square} \mathbf{E}.\mathbb{d}\mathbf{l} = -\frac{\partial}{\partial t}\int_{\text{coil area}}^{\square} \mathbf{H}.\mathbb{d}\mathbf{S}$ *to a small tangential loop at the interface. See graphics below. Blue arrow: H field. Red dashed rectangle: loop. Yellow vector and green vector: E field in the upper and lower medium, respectively.*

$$\int_{\text{complete loop}}^{\square} \mathbf{E}.\mathbb{d}\mathbf{l} = \mathbf{E}_{\text{yellow}}\,\mathbb{d}\mathbf{l} - \mathbf{E}_{\text{green}}\,\mathbb{d}\mathbf{l}$$

$$-\frac{\partial}{\partial t}\int_{\text{coil area}}^{\square} \mathbf{H}.\mathbb{d}\mathbf{S} = -\frac{\partial}{\partial t}\mathbf{H}_{\text{blue}} \times \mathbf{h} \times \mathbb{d}\mathbf{l}$$

what happens if you shrink h to zero? (hint: the yellow vector must be = green vector, but you must show the work). Finish the rest to show why light cannot change frequency going through the air-dielectric medium interface.

- graphics

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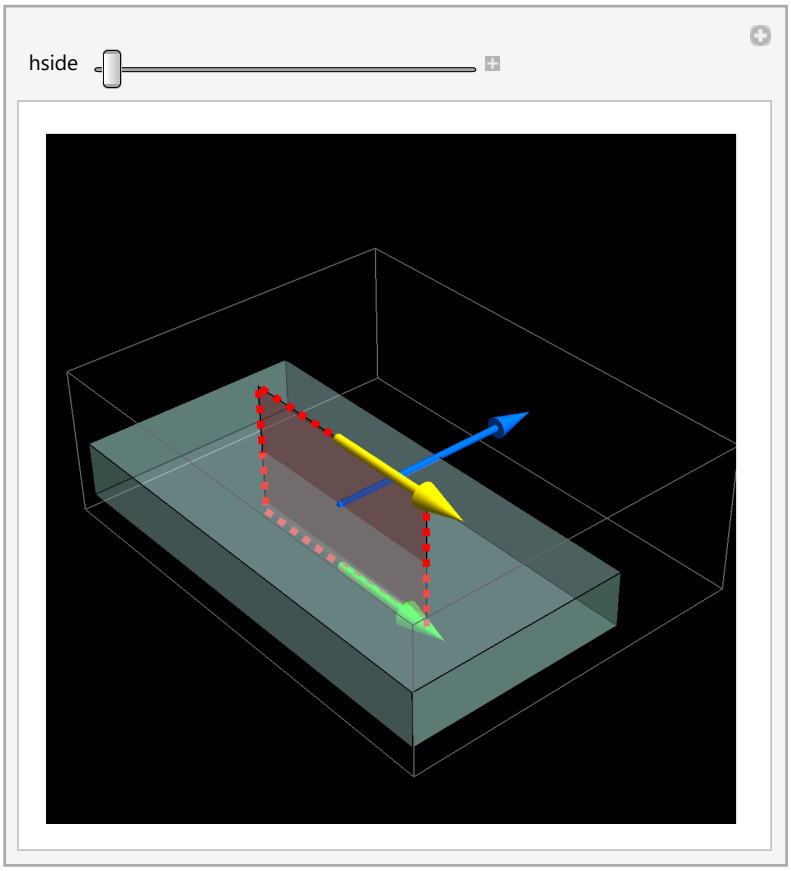
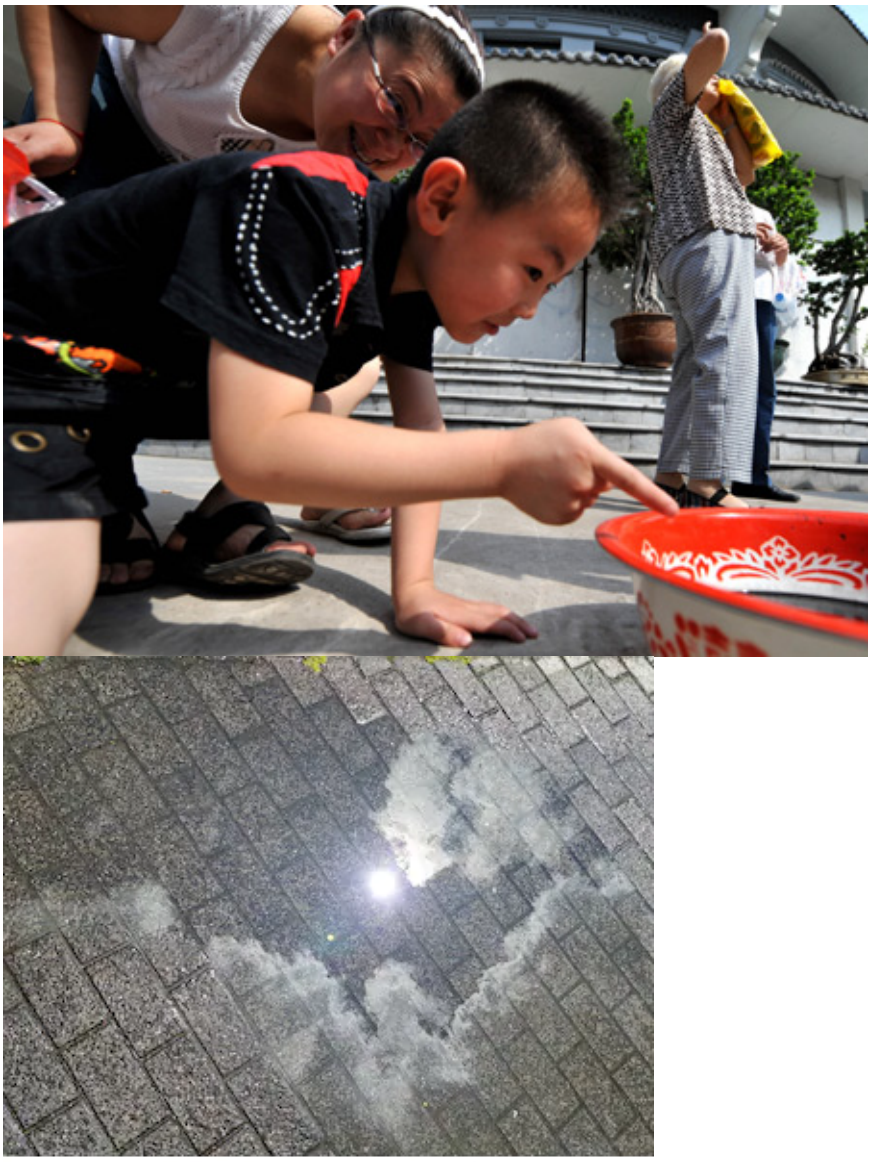


E. Sunlight reflection



Do you know that the kid was doing? watching solar eclipse reflection from water. We wouldn't look at the Sun directly, but it's OK if we look at its reflection in water? why? if someone asks you, what theory do you think can be used to explain? (*hint, in this course, there is only ONE theory that you will be using over and over...*).